

SECTION 16670

LIGHTNING PROTECTION SYSTEM

PART 1 GENERAL

1.1 SECTION INCLUDES

Furnish and install lightning protection system for building and associated structures including the following:

1. Air terminals and interconnecting conductors.
2. Grounding and bonding for lightning protection.
3. Lightning protection grounding electrodes.

NOTE: Edit 4 to match project requirements. Coordinate with specifications for electrical service equipment

4. Surge suppressors on electrical services and antenna leads.

1.2 LANL PERFORMED WORK

LANL will inspect the lightning protection system for acceptance and will apply for third party certification of the completed installation if required.

1.3 PERFORMANCE REQUIREMENTS

- A. Provide lightning protection system that conforms to the requirements of ANSI/NFPA 780 - *Lightning Protection Code*.
- B. Protect the entire building, including roof projections, chimneys, roof mounted equipment, associated exposed structures, electrical services, and external antennas.

1.4 SUBMITTALS

- A. Submit the following in accordance with the requirements of Section 01300:
 1. Catalog data for each component of the lightning protection system, including data substantiating that materials comply with specified requirements. Include data for roof adhesive when used.
 2. Certifications that firms meet qualifications specified in "Quality Assurance" Article to demonstrate capabilities and experience. Include list of completed projects with project names, addresses, names of Architects and Owners, and other information specified.
 3. Materials list of lightning protection system components showing quantity and manufacturer's catalog number.
 4. Shop drawings, not smaller than 1/8" = 1'-0" scale, showing the type, size, and locations of counterpoise, ground rods, down conductors, through roof/through wall assemblies, roof conductors, air terminals, and bonding connections.
 5. Project record documents that accurately record actual locations of air terminals, grounding electrodes, bonding connections, and routing of system conductors.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Engage a qualified installer to design and install the lightning protection system. Installer shall have either a current LPI Master Installer certification or current UL listing (Category OWAY) for Lightning Protection Installation. The installer shall have successfully completed not less than 5 lightning protection installations of similar scope to this project.
- B. Inspection: LANL will inspect the lightning protection system for acceptance in accordance with NFPA 780 - *Lightning Protection Code*.
- C. Listing and Labeling: Provide products specified in this Section that are UL listed.
- D. Conform to ANSI/NFPA 780 - *Lightning Protection Code* and ANSI/NFPA 70 - *National Electrical Code*.

1.5 SEQUENCING AND SCHEDULING

Coordinate installation of lightning protection system with the installation of other building systems and components, including electrical wiring, supporting structures and building materials, metal bodies requiring bonding to lightning protection systems, and building finishes.

PART 2 PRODUCTS

2.1 LIGHTNING PROTECTION SYSTEM COMPONENTS

- A. General Requirements: Provide lightning protection materials that conform to UL 96 - *Lightning Protection Components*.
- B. Components
 - 1. Materials: Use copper conductors and bronze fittings. Use aluminum only where in contact with aluminum structure, roofing or mechanical equipment.
 - 2. Air Terminals: Use 1/2 inch diameter, solid copper air terminals mounted on suitable bases with bolted pressure type cable connectors.

NOTE: Edit 3 to match project requirements. If structure is more than 75 feet in height, change conductor to minimum #15 AWG strand size and a minimum cross sectional area of 115,000 circular mils.

- 3. Main Conductor: Use copper cable with minimum #17 AWG strand size and a minimum cross sectional area of 57,400 circular mils.
- 4. Bonding Conductor: Use copper cable with minimum #17 AWG strand size and a minimum cross sectional area of 26,240 circular mils.
- 5. Cable Connectors: Provide bolted pressure type connectors. Finger, crimp, or pressure saddle style cable connectors are not acceptable.
- 6. Adhesive: Provide adhesive for cable fasteners and air terminal bases that is compatible with surface or roofing material to which bases or fasteners are to be attached.

NOTE: Edit 2.2 to match project requirements.

2.2 GROUND ROD

- A. Provide UL listed ground rod(s) as shown on the Drawings.
- B. Furnish ground rods with high-strength steel core and electrolytic-grade copper outer sheath, molten welded to core, approximately 10 feet long, 3/4 inches in diameter.
- C. Manufacturers: Blackburn, Thomas & Betts, Harger

NOTE: Edit 2.3 to match project requirements.

2.3 CHEMICAL GROUND ROD

- A. Provide UL listed chemical ground rod(s) as shown on the Drawings.
- B. Furnish chemical ground rods fabricated from Type K copper tubing approximately 10 feet long, 2 inches in diameter containing a hygroscopic electrolyte material. Furnish each chemical ground rod with a 24 inch long #4/0 copper pigtail, threaded removable cap, a protective cover box, and Bentonite clay backfill material.
- C. Manufacturers: Harger CGR Series, Lyncole Industries, Inc., LEC Inc., Superior Grounding Systems

2.4 GROUND ELECTRODE CABLE

Provide No. 4/0 AWG bare stranded, soft temper copper cable that conforms to ASTM B8, *Standard Specification for Concentric-Lay Stranded Copper Conductors*.

2.5 GROUND ELECTRODE BACKFILL MATERIAL

- A. Provide a Bentonite clay or equivalent commercial ground enhancement backfill material for ground rods and cable type electrodes.
- B. Backfill material, when at 300% moisture content (weight of water/weight of material)x (100), shall have a resistivity of approximately 250 ohm-cm and a pH of 8 to 10.
- C. Manufacturers: WYO-BEN Inc, ERICO

2.6 GROUND CONNECTORS

- A. Provide UL listed copper alloy connectors with silicon bronze hardware for making cable to pipe connections.
- B. Manufacturers: Burndy, O.Z.

2.7 EXOTHERMIC WELD CONNECTIONS

- A. Provide molds and welding material in kit form for making exothermic weld connections.
- B. In interior locations and in vaults, use low smoke emission type welding material.
- C. Match mold and weld material to material types, shapes and sizes to be joined.
- D. Manufacturer: ERICO Cadweld

2.8 COMPRESSION GROUNDING CONNECTIONS

- A. Provide UL listed wrought copper connectors, terminals and splices for making compression grounding connections on concentric lay ground electrode cable.
- B. Furnish connectors that have been tested successfully according to the requirements of IEEE Std. 837 - *IEEE Standard for qualifying Permanent Connections Used in Substation Grounding*.
- C. Provide hydraulic compression tools and dies that match the connectors.
- D. Match connector and die size to material shapes and sizes to be joined.
- E. Manufacturer: Burndy

NOTE: Edit 2.9 to match project requirements. Coordinate with specifications for electrical service equipment.

2.9 ELECTRICAL SERVICE SURGE SUPPRESSORS

- A. For electrical service equipment, provide UL listed secondary surge arresters that comply with ANSI/IEEE C62.11 — *IEEE Standard for Metal-Oxide Surge Arresters for AC Power Circuits* and are rated for "location category C3" as defined in ANSI/IEEE C62.41 — *IEEE Guide for Surge Voltages in Low-Voltage AC Power Circuits*.
- B. Manufacturer: Square D, "SDSA3650" for 480 V systems and "SDSA1175" for 120, 208, and 240 V systems.

NOTE: Edit 2.10 to match project requirements.

2.10 ANTENNA SYSTEM SUPPRESSORS

- A. At antenna lead entrances to buildings provide broadband HF/VHF/UHF coaxial surge protectors having the following characteristics:
 - 1. Surge capacity: 50 kA 8/20 μ s waveform, 500 Joules.
 - 2. Throughput energy:
 - a. 1.5 MHZ to 50 MHZ frequency range: less than or equal to 10 mJ
 - b. 50 MHZ to 1000 MHZ frequency range: less than or equal to 1 mJ
 - 3. VSWR: less than or equal to 1.2 :1
 - 4. Insertion loss: less than or equal to 0.1 dB over frequency range.
- B. Manufacturer: Polyphaser

NOTE: Edit 2.11 to match project requirements. This paragraph may be used for modifications to existing systems.

2.11 EXISTING MATERIAL

Any existing air terminals, air terminal bases, main conductors, bonding conductors, and cable connectors that meet the requirements of this Section and are in good condition may be re-conditioned and re-used. Re-conditioning includes removal of adhesive, removal of corrosion, and wire brushing contact areas.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine surfaces and conditions, with Installer present, for compliance with installation tolerances and other conditions affecting performance of the lightning protection system. Do not proceed with installation until unsatisfactory conditions have been corrected.

NOTE: Edit B, C, D, and E to match project requirements. These paragraphs may be used for modifications to existing systems.

- B. Make continuity tests of concealed parts of existing systems that may be re-used and are not available for visual inspection.
- C. Perform continuity tests to determine if suitable equipotential bonding exists between the lightning protection system and electric service(s), telecommunications service(s), antenna system grounds, and underground metallic piping systems.
- D. Perform ground-impedance measurements of existing lightning protection grounds.
1. Perform ground resistance measurements with the lightning protection ground system temporarily disconnected from all other grounding and piping systems.
 2. Use the "fall-of-potential" method in accordance with IEEE 81, *Guide for Measuring Earth Resistivity, Ground Impedance and Earth Surface Potentials of a Grounding System*. Use instrumentation specifically designed for ground impedance testing as defined in Section 12 of the above guide. Provide sufficient spacing of test electrodes so that the plotted curves flatten in the 62% area of the distance between the item under test and the current electrode. When sufficient spacing of electrodes is impractical for the "fall-of-potential" method, perform ground-impedance measurements using either the "intersecting curves method" or the "slope method", references 40 and 41 in IEEE Std. 81.
 3. If the lightning protection ground system resistance exceeds 25 ohms, add ground rods to obtain 25 ohms or less.
- E. Visually inspect surge suppression devices on electrical services and antenna systems for indication of damage. Replace missing or damaged surge suppression devices.

3.2 INSTALLATION

- A. Install components according to ANSI/NFPA 780 and as specified below.
- B. Install lightning protection systems as indicated, according to manufacturer's written instructions.
- C. Install conductors with direct paths from air terminals to ground connections. Avoid sharp bends and narrow loops.

- D. Cover lightning protection down conductors that are subject to physical damage or casual contact by personnel with Schedule 80 PVC conduit. Cover down conductors from grade level up to 8 ft above grade. Support conduit with conduit clamps spaced not more than 36 inches apart.
- E. Install air terminals on ridges, parapets, and around the perimeter of buildings with flat roofs at spacing not to exceed 20 feet. Install supplemental air terminals as required by and NFPA 780. Permanently and rigidly attach air terminals to prevent overturning.
- F. On single-ply roofing use adhesive recommended by manufacturer of the adhesive point bases and approved by manufacturer of the roofing material. Comply with adhesive manufacturer's installation instructions.
- G. Course down conductors over the extreme outer portions of the exterior of the building, such as corners, with consideration given to the location of ground connections and air terminals.
- H. Install a down conductor disconnect in each down conductor except the one nearest the building electrical service entrance. Locate disconnect between 8 ft and 10 ft above grade.
- I. Where down conductor is installed on structural column, bond down conductor to steel column or concrete column reinforcing steel at top and bottom of column.
- J. Bond grounded media on or in structure within 12 feet of ground to counterpoise electrode using copper bonding conductors.
- K. For structures exceeding 60 ft in height, bond grounded media on or in structure within 12 feet of roof to roof conductor using copper bonding conductors.

3.3 LIGHTNING PROTECTION GROUNDING ELECTRODE SYSTEM

NOTE: Edit 3.3 to match project requirements.

A. Counterpoise Electrode:

Install a counterpoise ring around the building or structure. Use #4/0 ground cable located 5 ft outside the building perimeter and at least 6 ft from any electrical system or communications system grounding. Install the counterpoise at least 3 ft below grade. Encase the counterpoise in a 2 inch envelope of ground electrode backfill material slurry.

B. Other Made Electrodes:

Where it is not possible to install a counterpoise ring as the lightning protection ground, or the ground must be supplemented, install one or more ground rods located 5 ft outside the building perimeter and at least 6 ft from any electrical system or communications system grounding. Install ground rods in 6 inch diameter augered holes with at least 10 ft separation between rods. Backfill hole with a slurry of ground electrode backfill material.

3.4 LIGHTNING PROTECTION CONNECTIONS

- A. Clean contact surfaces to which lightning protection connections are to be made. Remove non-conductive coatings such as paint, enamel, and oil film.
- B. Use the following connection methods unless otherwise specified or indicated on the Drawings:
 - 1. Use exothermic weld connections for underground or concealed connections of dissimilar materials.

2. Use exothermic weld or compression grounding connections for underground or concealed connections of like materials. Do not use compression grounding connectors for rope lay lightning conductor connections or for lightning protection ground rod connections.
 3. Use exothermic weld or bolted connections for accessible connections.
 4. Use high strength silicon bronze bolts, nuts, flat washers and toothed lockwashers for making bolted connections.
- C. Tighten lightning protection connectors, screws and bolts in accordance with manufacturer's published torque tightening values for connectors and bolts. Where manufacturer's torquing requirements are not indicated, tighten connections to comply with torque tightening values specified in UL 486A and UL 486B. Use a calibrated torque wrench.
- D. Use hydraulic compression tools to provide the correct circumferential pressure for compression connectors. Use tools and dies recommended by the manufacturer of the connectors. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed.
- E. Install exothermic welds in accordance with manufacturer's instructions and recommendations. Welds that are puffed up or that show convex surfaces indicating improper cleaning are not acceptable.
- F. Make connections in such a manner as to minimize possibility of galvanic action or electrolysis. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.
1. Use electroplated or hot-tin-coated materials to assure high conductivity and make contact points closer in order of galvanic series.
 2. Make connections with clean bare metal at points of contact.
 3. Make aluminum to steel connections with stainless steel separators and mechanical clamps.
 4. Make aluminum to galvanized steel connections with tin-plated copper jumpers and mechanical clamps.
 5. Coat and seal connections involving dissimilar metals with inert material such as red lead paint to prevent future penetration of moisture to contact surfaces.

3.5 SURGE SUPPRESSOR INSTALLATION

NOTE: Edit A to match project requirements. Coordinate with specifications for electrical service equipment.

- A. Install surge new suppressors on electrical services where suitable suppressors are missing or damaged.
1. Perform suppressor installation only on de-energized equipment.
 2. Schedule service de-energizing with Facility Manager.

3. Use approved lock-out/tag-out procedure that complies with LANL LP106-01, *Lockout/Tagout for Control of Hazardous Energy Sources for Personnel Safety (Red Lock Procedure)*.
4. Install surge suppressors in accordance with manufacturer's instructions.
5. Install surge suppressors in service equipment to minimize length of leads. Use subfeed lugs or other means to provide means of disconnecting surge suppressors without introducing excessive impedance in the surge suppressor circuit.

NOTE: Edit B. to match project requirements.

- B. Install surge new suppressors on external antennas where suitable suppressors are missing or damaged.
 1. Perform suppressor installation only on de-energized equipment.
 2. Schedule service de-energizing with Facility Manager.
 3. Use approved lock-out/tag-out procedure that complies with LANL LP106-01, *Lockout/Tagout for Control of Hazardous Energy Sources for Personnel Safety (Red Lock Procedure)*.
 4. Install surge suppressors in accordance with manufacturer's instructions.

3.6 FIELD QUALITY CONTROL

- A. A three part inspection of the lightning protection system will be conducted by the Contract Administrator prior to system acceptance.
 1. Roof system
 2. Down leads
 3. Grounding prior to backfilling or covering.
- B. Notify the Contract Administrator 10 working days in advance of the expected completion of the lightning protection system installation. Inspection can be scheduled in parts or by area depending on the system and construction schedule.
- C. Promptly correct all deficiencies as required by the Contract Administrator.
- D. When the system has passed inspection, LANL will apply for the LPI System Certification.

END OF SECTION